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# THE GENUS KEITHIA

ELIAS J. DURAND

(WITH PLATE 81, CONTAINING 11 FIGURES)

Dr. J. J. Davis has been good enough to place in my hands for study material of a discomycetous fungus parasitic on *Thuja*, which was collected by him in Wisconsin. It was first found July 14, 1908, at Mellen, Ashland Co., about twenty-five miles from Lake Superior, where, at two points along Bad River, *Thuja* was found bearing the fungus but not very abundantly. In July, 1909, the fungus was again met with in Oconto Co., in the Green Bay district, where it was very abundant on the same host. It seems probable, therefore, that the parasite is rather widely distributed in the northern part of Wisconsin.

Examination of the fungus showed its affinities to be with the genus *Keithia* Sacc., and it was named provisionally *K. thujina* Durand.<sup>1</sup> At that time I had not seen specimens of *K. tetraspora*, a European form, the typical and only described species of the genus. More recently, however, authentic material of that and of another allied species has become available which enables me to present the following account of this little-known parasitic group.

The genus *Keithia* was established by Saccardo<sup>2</sup> to include the single species described as *Phacidium tetrasporum* Phil. & Keith,<sup>3</sup> a parasite of *Juniperus*, in Scotland. The genus was referred to the Phaciidaeae, from the other members of which it differed in its 4-spored ascospores divided by a single septum into two unequal cells. Authentic specimens of *Phacidium tetrasporum* collected at Forres, Scotland, June, 1880, by Rev. J. Keith, now in the New York State Museum of Natural History, at Albany, have been examined. A related species parasitic on *Tsuga*, in New Hampshire, was described by Dr. Farlow, in 1883,

<sup>1</sup> Trans. Wisc. Acad. Sci. Arts Let. 16: 756. 1909.

<sup>2</sup> Syll. Fung. 10: 49. 1892.

<sup>3</sup> Gardeners' Chronicle, N. S. 14: 308. 1880.

under the name *Stictis Tsugae*.<sup>4</sup> Examination of authentic material has shown it to belong in *Keithia* rather than in either *Stictis* or *Propolidium*, to which it was referred by Saccardo. The genus *Keithia*, therefore, is known to possess three species, all of which are parasitic on the leaves of conifers. One is on *Juniperus*, in Europe, the others on *Tsuga* and *Thuja*, respectively, in America.

Phillips and others have referred the parasite of juniper to the Phaciidae on account of its dark color, and its supposed laciniate method of dehiscence. Maire and Saccardo in describing the genus *Didymascella* (later regarded by Maire as a synonym of *Keithia*) remarked that it certainly belongs nearest to the Phaciidae. So long as knowledge of the genus was confined to the originally described species such a reference seems not at all remarkable. Further study of the group, especially of the two American representatives, throws a somewhat different light on its affinities, and seems to indicate that it might better be referred to the Stictidiaceae. Maire has pointed out, with good reason, that in the case of *K. tetraspora* the fungus itself does not split in a laciniate manner, but that the lobes are really formed of the epidermis of the host, which is ruptured by the expanding ascoma beneath.

There seems little room for doubt that the three species here included in *Keithia* are congeneric. The habit, all being parasites of coniferous leaves; the erumpent ascomata bursting the epidermis only; the uniformity of structure of the poorly developed excipulum; the small number and peculiar septation and color of the spores, all indicate that we are dealing with a very compact group. Comparison of these three species shows that in the case of *K. thujina* and *K. Tsugae* the color is much brighter than in *K. tetraspora*, and the covering epidermis is thrown off as a scale rather than splitting stellately. When completely moist the ascoma becomes somewhat elevated and cushion-like. The general resemblance of these plants to *Propolis faginea* is so great that it seems that they must be associated in the same family. Sections show that in all species of *Keithia* the excipulum and hypothecium are very poorly developed, but certainly are not lacking as stated

<sup>4</sup> Appalachia 3: 245. 1883.

in the description of *Didymascella*. The substance of the ascoma is soft and waxy when fresh. On the basis of these characters I believe that the affinities of *Keithia* are not with the Phacidiaeae, with which European authors have associated it, but with the Stictidiaceae, to which the parasite on *Tsuga* was originally referred by Dr. Farlow. If this disposition is the correct one we have in *Keithia* a genus of strictly parasitic fungi in a family otherwise almost exclusively saprophytic.

The genus may be characterized as follows:

A genus of the Stictidiaceae parasitic on leaves of conifers. Ascomata erumpent, rupturing the epidermis either lacinately or in the form of a scale, bright-colored to dark. Spores 2 or 4, becoming olive-brown, divided into two unequal cells by a septum near one end.

#### SYNOPSIS OF SPECIES

Spores 4 in each ascus.

Epidermis ruptured lacinately, on *Juniperus*. 1. *K. tetraspora*.

Epidermis ruptured in the form of a scale, on *Tsuga*. 3. *K. Tsugae*.

Spores 2 in each ascus, epidermis rupturing by a scale,  
episporous punctate, on *Thuja*.

2. *K. thujina*.

1. KEITHIA TETRASPORA (Ph. & Keith) Sacc. Syll. 10: 49. 1892

*Phacidium tetrasporum* P. & K. Gard. Chron. N. S. 14: 308.  
1880.

*Didymascella Oxycedri* Maire & Sacc. Ann. Myc. 1: 418. 1903  
(fide Maire, Bull. Soc. Myc. Fr. 21: 140. 1905).

Hypophylloous, erumpent, ascomata at first buried beneath the epidermis, then breaking through and rupturing the epidermis by 3-4 laciniae, seated in the midst of a small, circular, yellowish-brown spot; the pustule elliptical, .75-1 mm. long, .5 mm. wide; disk brownish-black. Ascii clavate,  $175 \times 16-18 \mu$ , apex rounded, not blue with iodine. Spores 4, uniseriate, at first hyaline, later becoming olive-brown, ellipsoid to piriform-ellipsoid, the smaller end occasionally prolonged to form a short beak-like projection, divided by a septum close to one end into two very unequal cells, the smaller being as often distal as proximal,  $21-24 \times 13-16 \mu$ . Paraphyses cylindric, hyaline below, septate,  $2-3 \mu$  thick, the apex clavate, olive-yellow,  $8-9 \mu$  thick.

On living leaves of juniper (*J. communis*, probably), Forres, Scotland, 1880, Rev. J. Keith.

Phillips described the fungus as occurring on the upper side of the leaf, but in the twenty-five or more infected leaves examined it is hypophylloous without exception. I have seen no reference to other collections of this species before 1903. In that year a parasite of *Juniperus Oxycedrus*, from Corsica, was described under the name *Didymascella Oxycedri*, by Maire and Saccardo. I have not seen specimens of this fungus, but Maire, following the suggestion of Patouillard, later came to the conclusion that it does not differ from *Keithia tetraspora*.

The erumpent ascomata remind one strongly of the pustules of some *Puccinia*. Sometimes as many as three ascomata may appear on a single leaf of the host. The spores are quite similar to those of *K. thujina*, but there are four in each ascus, the septum is not quite so close to one end, and the walls are not pitted. The laciniate rupturing of the epidermis is distinctive, as well as the dark color of the hymenium.

## 2. *Keithia thujina* sp. nov.

Ascomata epiphyllia, erumpentia, orbicularia vel elliptica, pulvinata, olivacea vel brunneo-olivacea, 1-1.25 mm. longa, .5 mm. lata; epidermis supra integra non laciniatim decidens. Asci clavati, 80-100  $\times$  18-20  $\mu$ . Sporae duae, brunneo-olivascentes, elliptico-piriformes, septo ad apicem anteriorem inaequaliter divisae, punctatae, 22-25  $\times$  15-16  $\mu$ . Paraphyses furcatae, septatae, clavato-incrassatae, olivaceae.

Ascomata epiphyllous, erumpent, at first buried beneath the epidermis which is lifted up, breaks around the margin, and finally falls away as an entire flap or scale, exposing the ascoma in the form of a cushion-like elevation. Ascomata circular to elongate-elliptic in outline, straight or curved, convex above, having the form of depressed cushions which are raised slightly above the surface of the substratum, .5 mm. broad, up to 1.25 mm. long; disk olive to olive-brown. Asci clavate, stout, 80-100  $\times$  18-20  $\mu$ , opening by a pore, not blue with iodine. Spores 2, placed end to end, at first hyaline, finally becoming olive-brown, broadly ellipsoid or piriform-ellipsoid, the smaller end uppermost, at first continuous, finally divided by a single transverse wall close to the distal end into two very unequal cells, episporae with minute pits over its whole surface, 22-25  $\times$  15-16  $\mu$ . Paraphyses branched below, septate, strongly clavate-thickened in the distal third, cohering, somewhat longer than the asci, 2-3  $\mu$  thick below, 5-8  $\mu$  thick above, olive.

On living leaves of *Thuja occidentalis*, Mellen, Wisc., 14 July, 1908 (Durand no. 6259, type); Oconto Co., July, 1909 (Durand no. 6910), Dr. J. J. Davis.

This species differs from *K. tetraspora* in the 2-spored asci, pitted spores, olive hymenium and the method of rupturing the covering epidermis. The fungus attacks the young, living foliage so that the scale-like leaves turn brown and die. In old specimens the ascomata fall out, leaving a hole extending nearly through the leaf. The septum in the spore is not always evident with low or medium powers of the microscope, but comes out best under an oil immersion objective. The same is true of the markings of the episporae, which consist of minute pits extending about half way through the wall. Such pit-like markings are quite unique in either the Phacidiaeae or Stictidiaceae.

The parasite does not seem to have any visible effect on the vigor of the tree, according to Dr. Davis's observations, since it destroys only a limited amount of leaf-tissue. Experience with other fungous diseases, however, leads one to suspect that under favorable conditions, or in certain seasons, it might become serious.

### 3. *Keithia Tsugae* Farlow

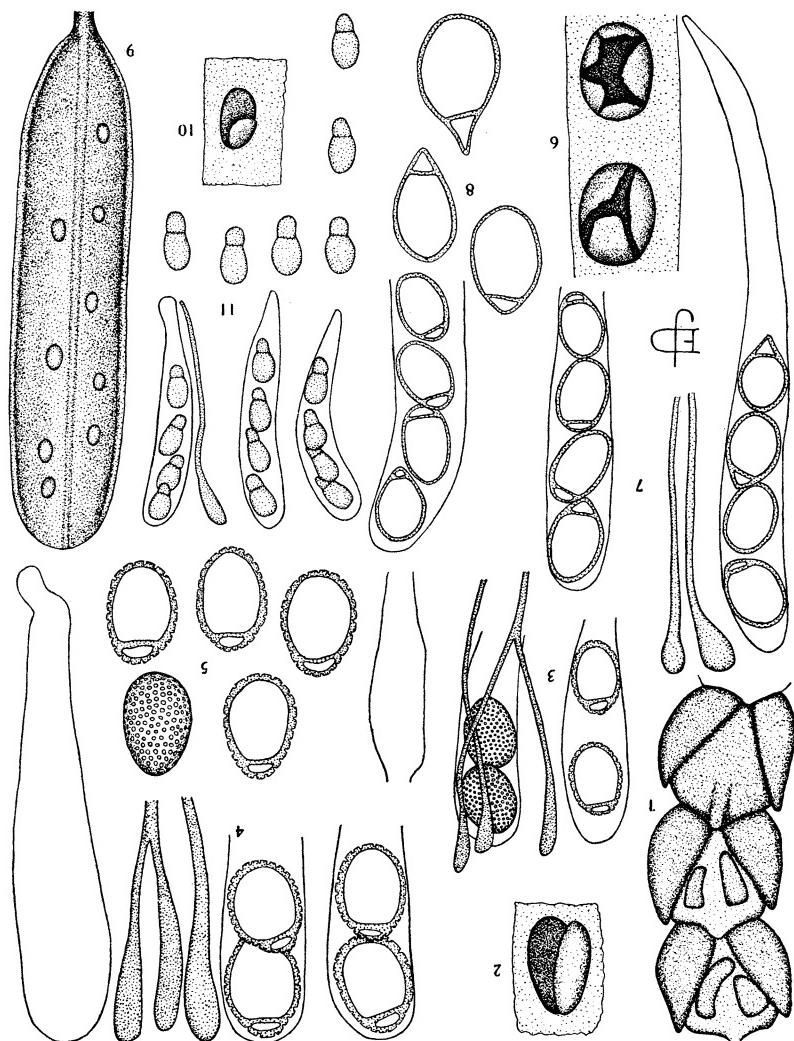
*Stictis Tsugae* Farlow, Appalachia 3: 245. 1883.

*Propolidium Tsugae* (Farlow) Sacc. Syll. Fung. 8: 668. 1889.

Hypophyllous, numerous, scattered; ascomata minute, at first buried beneath the epidermis which is finally ruptured and turned to one side as a scale, becoming more or less elevated and cushion-like, dark brown, orbicular to elliptic, .3-.5 mm. in diameter. Asci oblong-clavate, apex rounded, not blue with iodine,  $58-65 \times 13-16 \mu$ . Spores 4, uniseriate, at first hyaline, finally becoming greenish brown, ellipsoid-ovoid, divided by one septum into two unequal cells of which the proximal is smaller, constricted at the septum,  $13-16 \times 6-8 \mu$ , smooth. Paraphyses cylindric, septate, hyaline below, the tips clavate, olive-brown,  $4-5 \mu$  thick.

On living and dead leaves of *Tsuga canadensis*. New Hampshire: Shelburne and Lake Sunapee, July-Sept., Dr. W. G. Farlow; Wisconsin: Price Co., 13 Sept., 1911, Dr. J. J. Davis.

I have examined a portion of the type of this species kindly placed at my disposal by Dr. Farlow, as well as other specimens from his collection in the herbarium of the New York Botanical

1-5. *KEITHIA THUJINA* Durand6-8. *KEITHIA TETRASPORA* (Ph. & Keith) Sacc.9-11. *KEITHIA TSUGAE* Farlow

Garden. The material from Lake Sunapee is more mature than the rest, and shows spores conspicuously colored. This character, as well as the tetrasporous ascii and the spores divided into two very unequal cells, indicates its close relationship to *K. tetraspora* and *K. thujina*. The covering epidermis falls as a scale as in the last named species.

Dr. Davis's recent collections are also mature and agree in all respects with those from New Hampshire.

Dr. Farlow informs me that since he first found it, in 1882-3, he has secured more mature material in several localities, which has quite modified his original view regarding this species. In the type the spores are immature and hyaline, and through an error were described as 8-spored instead of 4-spored. Comparison with authentic *Keithia tetraspora*, in Europe, convinced him that his *Stictis Tsugae* is congeneric, and should be called, therefore, *Keithia Tsugae*.

The same writer speaks of the parasitism of this species as follows: "The fungus appears only on the under side of the leaves, which turn brown and quickly fall. It was first noticed in August, 1882, on a tree affected with *Peridermium Peckii*. In September, 1883, it was found on a large number of trees, and had nearly destroyed the foliage. It may be considered a disease which does considerable harm."

On the basis of observations recently made upon this species in Wisconsin, Dr. Davis entertains some doubts about its parasitic nature. He has found no instances in which it appeared on undoubtedly living leaves, and he is convinced that it is not so certainly parasitic as is *K. thujina*.

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#### EXPLANATION OF PLATE LXXXI

*Keithia thujina*. Fig. 1. Portion of branch of *Thuja* showing four ascomata.  $\times 6$ . Fig. 2. Single ascoma much enlarged showing the epidermal scale falling away. Fig. 3. Ascii, paraphyses and spores. Figs. 4-5. Ascii, paraphyses and spores drawn with the oil immersion objective.

*Keithia tetraspora*. Fig. 6. Portion of leaf of *Juniperus* showing two ascomata exposed by the stellate splitting of the epidermis. Fig. 7. Three ascii, paraphyses and spores. Fig. 8. Three spores more highly magnified.

*Keithia Tsugae*. Fig. 9. Leaf of *Tsuga* showing nine ascomata, much enlarged. Fig. 10. Single ascoma greatly enlarged exposed by falling epidermal scale. Fig. 11. Ascii, paraphysis and spores.